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RESEARCH ARTICLE

Physics is the Science of Inanimate Nature. And if Nature is Alive!?

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Abstract

The civilization that has conquered the modern world is technological. It displaces all living things from the world and replaces them with artificial ones. The attempt to cognize the world with the help of the prevailing scientific method leads to the emergence of more and more new problems, the resolution of which leads to the emergence of new problems, etc. Western scientism is slipping, according to P. Feyerabend's definition, to outright "raciofascism." Morality is giving way to rationalism and the criterion of benefit. According to Konrad Lenz, one of the greatest biologists of our time, the question of morality arises only if the object of study is a living thing. A thorough study of the structure of the body will never create an image of a living person. For some approximation to the truth it is necessary to study his emotions, desires, thoughts, i.e. his soul, his spiritual state. Apparently, we should do the same when studying Nature, if it is alive. The assumption made in this work about the complex nature of all physical quantities can become a bridge between the rationalism, reigning now in science, and panpsychism, the ancient notion of reasonableness and spirituality of Nature. Apparently, it is time to recognize that Nature is not dead, but alive. A new look at the nature of complex numbers, perhaps, will lead to a new toolkit for studying Nature.

Keywords: Problems of Modern Physics, Universe, Higher Power, Panpsychism, Complex Number Field, Differential Equations, Numerical Solution, Plasma, Vlasov Equation, Landau Damping, Schnoll Experiments.

1. Hard Problems of Modern Physics

The end of the XIX century was probably a period of the greatest unanimity, or rather, unanimity among physicists. There was one physics, goals, methods and results of which were accepted by all physicists, with the exception of individual private issues, the solution of which, of course, in the process of further study should have led to one result, obvious to all. After all, physics studies the laws of the outside world, and they are united and independent of an outsider. This ideological unity rested on comprehensive, as it seemed then, the results of the main science - mechanics. As Helmholtz said: "The ultimate goal of natural science is to find movements and their driving forces that underlie all changes, i.e. to resolve in mechanics. "

The new science that has arisen - electrodynamics was also equipped with a mechanically understood ether. Successfully describing the world of electromagnetic phenomena, this classical electrodynamics turned out to be unable to explain two experimental facts: the curve of the radiation spectrum of a completely black body and the results of the Michelson-Morli experience, set to detect the Earth's movement regarding the ether.

From attempts to resolve these problems, a new non -classical physics was born: quantum mechanics and the theory of relativity, both far from a mechanistic understanding of nature. The time of unanimity among physicists has come into the past. Some physicists, including Einstein, did not take on the probabilistic nature of quantum mechanics, some of the physicists

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could not agree with the new interpretation of space and time contained in the theory of relativity. Physics was divided.

“I argue that in any private teaching about the nature of genuine science only as much, as mathematics there will be found” - these words of Kant emphasize the unconditional prominence of mathematics in the rationalistic activity of a person who knows the world. Mathematics is the only one of the sciences that has the ability of evidence -based reasoning based on the method of deduction. And in mathematics there is a desire to establish the building of science on a smaller number of entities. In the second half of the XIX century an attempt was made to build mathematics based on the theory of sets. But the result of this universalizing activity in mathematics turned out to be exactly the same as in the similar process of mechanization of physics - a single mathematics broke up into various directions, each of which sought to overcome the paradoxes that suddenly arose in the theory of sets. Four main directions of modern mathematics can be distinguished: intuitionism, logicism, formalism and constructivism, and it cannot be said that they do not contradict each other.

Classical formal logic is bivalent: any statement is either truly or false, the third is not given. Brauer, the founder of intuitionism, in an attempt to get out of the crisis, was introduced a new logic that denied the postulate of the exclusion of the third for endless sets. After Brauer, they began to use various polyvalent logics.

Both physics and mathematics broke up, lost their original unity when trying to universalize them. An attempt to know the world with the help of the dominant scientific methodology leads to the emergence of more and more new problems, the resolution of which is to the emergence of next problems, etc. Samples of the substance are divided and divided, spending more and more energy and colossal material means. A hundred years ago, they hoped to get closer to some final results, but got something completely incomprehensible, they could only come up with the name of this: “Dark Matter” and “Dark Energy”. If you discard academese, we know about the world no more than a hundred or five hundred years ago. And the world stands as stood, everything functions and is interconnected in some unknown way.

Civilization, conducting the modern world, is technological. It replaces all living things from the world and replaces it artificial. Life begins to be regulated by a mechanistic science, which originally developed as a science that studies dead matter. One of the founders of modern natural science Johann Kepler wrote: “My goal is to show that the skyey machine should not be compared with the divine organism, but with the clock mechanism” [1]. Morality gives way to rationalism and the criterion of benefit. According to Conrad Lenz, one of the largest biologists of our time, the question of morality arises only if the object of study is living.

I.R. Shafarevich believes that the ideological movements that have prepared the technological civilization are associated with the spiritual crisis, which Western Europe survived in the XVI century: Reformation and emerging rationalistic Protestantism. But historian Lynn White considers the influence of not only Protestantism, but wider - of all Christianity [2]. In his opinion, machine civilization and the subsequent ecological crisis came out of the Christian understanding of God, for it replaced the more ancient perception of the world, according to which all nature is animated and thereby affined to man. Christianity, according to White, tore off God from the world, recognized only man created in the image of God, and thereby gave a person the right to use nature for his need. This opens the road to the ruthless exploitation of nature. The same views of V. Rozanov, who believed that Christianity generally leads a person from the world, teaches that the whole world lies in evil, that one should not love peace or that in the world [3].

Modern researcher M. Zhutikov writes: “We are“ one blood ”with nature, but we do not want to hear its language, we are stunned by our civilization and look only at it, as obsessed with a point. But in fact, we are flesh from flesh of life, we are herself, we are her singers and her wonderful obsessed ”[4].

But this frantic pace of the scientific and technological race, the desire to conquer nature and scoop out everything that can be done with the help of machines, has led to a surprising result: the human designer becomes a hostage and slave of these machines. The processes are out of control, technological civilization is no longer for the benefit of man, at least materially; unrestrained, “Rabelaisian” consumption has given rise to the ideology of production for production's sake; man, and even more so his spiritual world, have become of little importance for “progress”. And there is no way out of this situation within the framework of the consumer society. An ecological, social, and political catastrophe has broken out. According to P. Feyerabend's definition, Western scientism is sliding toward outright “raciofascism”; the nightmare of biotechnology looms on the horizon; having failed to understand the micro- and megamir, they have finally decided to correct man himself: who needs spurs on his feet and who needs a saddle on his back.

And science, whatever it is, is being killed today: it is practically not financed, the form of applications for grants, sent down by "managers" from science, increasingly resembles the notes of a madman, where they demand to confess in what quarter of what year what discovery will be made, and then try not to make it. Leibniz and Newton would have been very surprised - in what developed their "artisanal" compared to the methodology of the new time to deal with nature. The scientific prestige is lowered below the plinth, the training of scientific personnel and education in general is consistently destroyed. Where is the saving way out? Do we correctly understand or, better to say, perceive the world around us?

2. The Universe and God

Not accepting the anthropocentric idea of God of the Judeo-Christian religions, Einstein came to the idea of a Higher Power acting in the Universe. The rationalistic beginning alone is not sufficient for knowledge of the World: "Science without religion is lame, religion without science is blind." One of Einstein's most intriguing ideas was the concept of hidden variables. He could not accept quantum mechanics in its standard interpretation, which assumes fundamental randomness at the micro level. Einstein believed that there must be some hidden factors determining the behavior of particles that we cannot yet detect. Hence his words in an argument with Niels Bohr: "God doesn't play dice." Quantum phenomena must be based on deterministic laws.

Nikola Tesla, who disagreed with Einstein's physics, also came to the idea of a deified Universe: "Every mystery of the universe solved, every discovery made brought me closer to the idea of the existence of an incomprehensible Supreme Design, a Law above all laws." As Tesla writes in his memoirs, there began a series of insights that led to those outstanding inventions and ideas with which he enriched our knowledge of the world of electricity. Reflecting on this phenomenon, the researcher came to the idea that these insights came to him from the "intelligent core of the universe", which he identified with God.

Both scientists came to the idea of a Higher Power dominating the world as a result of realizing the impossibility of approaching the knowledge of Nature only by rationalistic (scientific) methods. Many other prominent thinkers also felt the manifestation of divine activity in the Universe, for example, Newton, who thought about the problem of the prime mover that started the processes in the Universe. This led him to a careful study of the biblical texts.

3. Panpsychism

It was only a hovering idea of Divine power in Nature in the minds of the investigators. However, there is an idea or notion about the nature of this Divine power. This is panpsychism-the suggestion that inanimate objects can have consciousness. Scientists claim that consciousness is no longer a feature of human subjective experience. Consciousness is the basis of the universe, which is present in every particle and in all matter. Aristotle, Plato and other ancient philosophers came to this view. At the crossroads of XX and XXI centuries, due to insurmountable difficulties in physics, this idea was again in demand.

Traditional attempts to explain the phenomenon of consciousness continue to fail. In the present day, respected philosophers, physicists and medical community, including such famous scientists as neurophysiologist Christoph Koch and physicist Roger Penrose, adhere to the theory of panpsychism. Thus, Penrose has suggested that consciousness is not necessarily related to biological organisms. He believes that consciousness, as such, derives from some as yet unexplored property of quantum entanglement.

In 1995, Australian philosopher David Chalmers formulated the "hard problem of consciousness." "Physics explains chemistry, chemistry explains biology, and biology partially explains psychology," the scientist notes. But, he says, there is still no answer to the question of what consciousness is. The materialist point of view claims that consciousness has its origin solely in physical matter. However, it is unclear exactly how this works. "It is very difficult to derive consciousness from non-consciousness," concludes Chalmers [5]. Consciousness is separate and distinct from physical matter, but then there is the question of how consciousness interacts with and affects the physical world. Panpsychism may well mean that "any system is conscious". "Rocks will be conscious, spoons will be conscious, the Earth will be conscious," says Chalmers. Interest in panpsychism has grown due to the increasing academic study of consciousness and self-consciousness.

"Why do we think that common sense is a good guide to the order of the universe?" - asks Philip Goff, a professor of philosophy at Central European University in Budapest. "Einstein tells us strange things about the nature of time that contradict common sense; quantum mechanics has nothing to do with common sense," he notes. "It is foolish to deny consciousness to the nature of things and then ask about the nature of consciousness itself," Goff summarizes. He goes on to note that thinkers such as philosopher Bertrand Russell and physicist Arthur Eddington have made serious arguments in favor of panpsychism. "Physics is not as good an aid to understanding the nature of matter as is commonly believed. Eddington argued that there is a gap in our understanding of the universe. We know how matter behaves, but not what it is. Into this gap we can place consciousness," writes Goff [5].

Panpsychism is, in fact, an intellectual elaboration of animism, the ancient idea of people that everything has a soul: the sky, the sun, thunder, lightning, rainbow, rain, river, stone, forest, tree, etc. Many scientists come to the conclusion that the Earth is a living and intelligent being. In their opinion, the Earth is aware of people living on its surface who disturb it by drilling, explosions and disturb the ecology of the biosphere. The Earth is an extremely energy-rich, highly organized and evolving system, whose ability to adapt is many orders of magnitude higher than that of mankind. The recent increase in earthquakes, hurricanes, tsunamis, floods and extreme temperature fluctuations is believed to be the Earth's response to humanity's ill-considered actions. In the 1970s, British ecologist James Lovelock proposed the "Gaia hypothesis"[6]. It refers to the Earth as a superorganism that, thanks to self-regulation, is able to maintain the basic parameters of the environment at a constant level.

Is the Universe itself alive? It turns out that atoms resemble solar systems, the large-scale structures of the universe resemble neurons in the human brain, and there are also curious coincidences: the number of stars in a galaxy, galaxies in the universe, atoms in a cell and cells in a living being is approximately the same (from 10^{11} to 10^{14}). The following question arises, "Are we not simply brain cells of a larger planetary-scale creature?" [7]. It is necessary to conceptualize this. A thorough study of body structure will never create an image of a living human being. For some approximation to the truth it is necessary to study his emotions, desires, thoughts, i.e. his soul, his spiritual state. Apparently, we should do the same when studying Nature, if it is alive.

4. Complex Quantities as a Possible Basis for a "New Physics"

Let's turn to the problem of complex numbers. Using the imaginary unit $i=\sqrt{-1}$, a mathematician or a physicist does not feel this object; and it is impossible to feel or understand, imagine as clearly as, let's say a positive number. Nevertheless, starting from the linguistic background: "imaginary" means "non-existent." How so?: Does "non-existent" number exist?

Looking back to the past, we can make a conclusion that the pioneers of complex numbers used them both by necessity and by convenience, which they provided, but nobody had a clear understanding of the connection that existed between the complex numbers and the reality. For subsequent generations of mathematicians, the complex numbers have become a real thing, which was to be accepted.

Now it is believed that real numbers correspond to physically measurable quantities, and complex calculus in physics is supposed to be of a formal mathematical, auxiliary nature.

Development of the natural sciences shows that the objects that previously existed only as mathematical "ideal" concepts later acquired an actual meaning and were included in the family of physical objects. Currently, physical quantities may be described both by negative and irrational numbers.

The complex field of numbers has a key distinctive feature: it is algebraically closed. Restriction of physical quantities only by the field of real numbers seems logically unsatisfactory, since mathematical operations often deduce them from the field of original definition.

Here appears a cardinal question about the relation between the concepts of quantity and number. It seems quite natural to accept the following definition offered, for example, by A.N. Kolmogorov [8]: "A number is a relation between two quantities". With such definition, the fact of the existence of complex numbers immediately gives rise to the conclusion about the existence of complex quantities.

It is possible that the imaginary part is unobservable, but at the same time it is necessary inherent in a physical quantity, being something like a hidden parameter, and manifests itself only indirectly, forcing the system to move along one or another path. In other words, the imaginary part of a quantity is its "soul", making the system move in different directions under the same external conditions depending on the filling of this "soul". In this sense, we can say that Nature is a living being

The line of reasoning of a modern physicist is as follows: "We live in the real world; therefore, all quantities should be described by real numbers." This statement seems to be completely natural without any additional argumentation. Such situation is an example of paradigm and is taken for granted by scientists. It may be said that the advancement of science confirms this thesis.

However, it seems that there are contrary examples as well.Imaginary time τ=ict is introduced into the relativity theory, and only in this form together with three spatial coordinates, it forms a four-dimensional space-time. The fourth axis of space-time is an imaginary quantity.

The basic object of the quantum mechanics - a complex-valued wave function is referred to as not being of any physical sense, but the square of this function has physical sense. Already this conclusion is concerned, moreover in the quantum-mechanical superposition principle should appear exactly the wave function, which has no physical meaning, rather than the function square, which does not have this meaning.

Because of mathematical reasons about the necessity of completeness of the system of wave functions, a notion of negative energy levels was introduced into the relativistic quantum mechanics. The physical interpretation of this formal mathematical result is given by Dirac who postulated principal unobservability of the states with negative energy because particles occupied all levels of negative energy, and consequently, any transitions between any two levels which might be observed, are impossible (vacuum state). However, postulating in the beginning principal unobservability of such states, physicists speak then about the interaction of hydrogen atom with vacuum (Lamb shift).

When solving a differential equation, we have to solve the so-called characteristic equation first. This equation is algebraic and its solution is sought on the field of complex numbers. In the theory of oscillations, for example, such quantities as frequency and wave vector, and hence their inverse quantities - oscillation period and wavelength - become complex-valued.

Probably it is time for physics to introduce complex numbers into common use, i.e. to make all the observed quantities correspond to complex numbers instead of real numbers.

All the above, in our opinion, necessitates complexification of the physics. The complexification properly lies in the assumption that quantities treated in all physical laws are complex. Theoretically, we shall try to determine whether the situation where the solution for the real part of the entered complex quantities essentially differs from the real common solution defined by the equations of any physical law is possible.

The subject of our examination will be the differential equations, which are the basis of modeling of physical processes.

The paper offers to apply the technique of examination of the Lyapunov [9] stability to the complex plane to study the dependence of the solution of the problem on the fluctuation of imaginary parts of additional conditions in the vicinity of zero.. Will the continuity of dependence of the solution on change of the starting conditions remain in this case?

4.1 Study of the Equations of Classical Physics

Any equation contains three elements: functions, arguments, and coefficients. Problem formulation necessitates, in general, considering all the elements as complex-valued, but in solving the nonlinear complex-valued equations, we shall take into consideration only functions since more simple linear equations make it also possible to consider the influence of complex-valued quantities in arguments and coefficients.

4.1.1 Linear First-Order Equation with Constant Coefficients

The equation

$$\frac{dN}{dt} = -\lambda \cdot N \tag{1}$$

describes the phenomenon of radioactivity, light absorption, gamma-ray absorption, equilibrium of phases (Clapeyron-Clausius equation). That is an autonomous equation; N function and λ parameter are complex-valued.

Let's consider an initial value problem (Cauchy problem)

$$N(t=0) = N_0 \tag{2}$$

with the purpose of examination of the influence of small imaginary parts of initial conditions and parameters on the real part of the solution.

The solution of the problem (1), (2)

$$N = N_0 \exp(-\lambda \cdot t) \tag{3}$$

is examined numerically in the complex domain. The results of the solution are shown in Fig. 1÷5. Calculations are carried out for half-life period T1/2=

10 days (λ= ln2/T1/2). Relations of imaginary parts to actual parts for all quantities were taken identical:

Fig. 1a (J/R= 0) demonstrates an ordinary radioactive decay law. The phase-plane portrait in {N, dN/dt} coordinates shown in Fig. 1b represents a stable node.

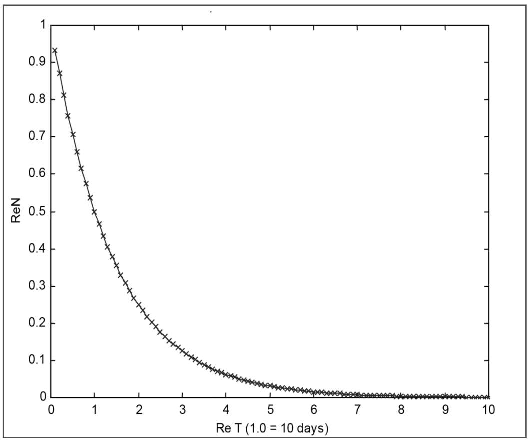

Figure. 1a. *Radioactivity. J/R=0*

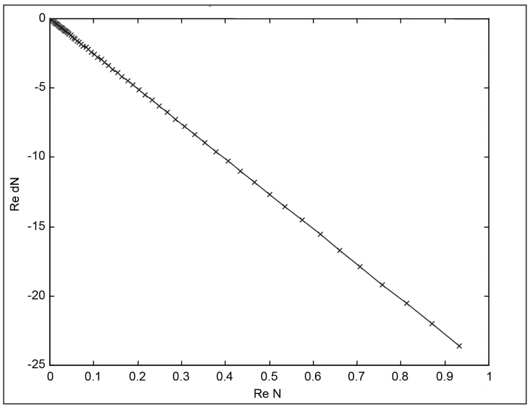

Figure. 1b. *Radioactivity. J/R=0*

Figs. 2a and 2b, (J/R= 0.3), explicitly reveals deviation from the known law of radioactive decay. As J/R parameter crosses zero, the first bifurcation occurs, and a stable node transforms into a stable focus.

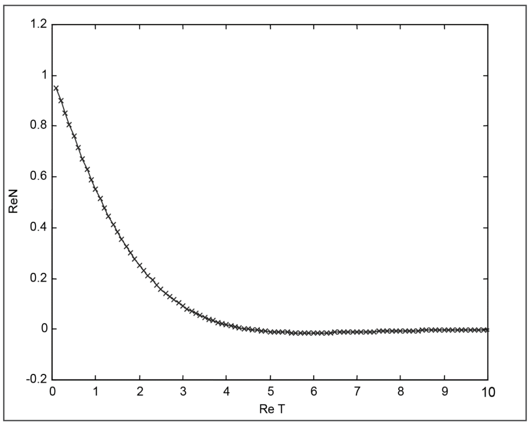

Figure 2a. *Radioactivity. J/R=0.3*

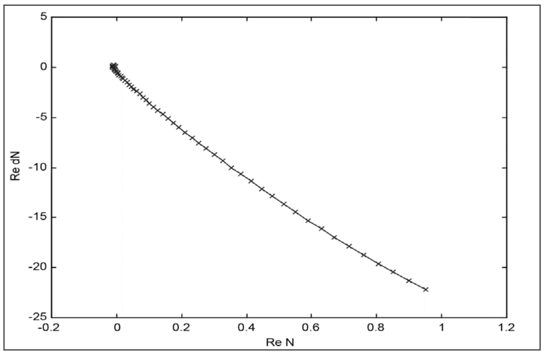

Figure 2b. *Radioactivity. J/R=0.3*

Fig. 3, (J/R= 0.9) represents a well expressed stable focus.

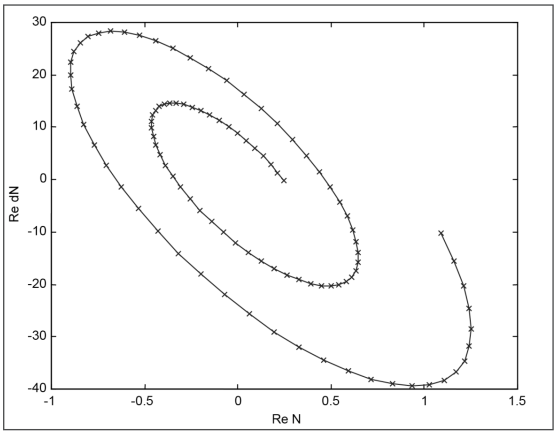

Figure 3. *Radioactivity. J/R=0.9*

At the J/R= 1 value (refer to Fig. 4), the second bifurcation happens - a Hopf bifurcation when a stable focus turns into a limit cycle.

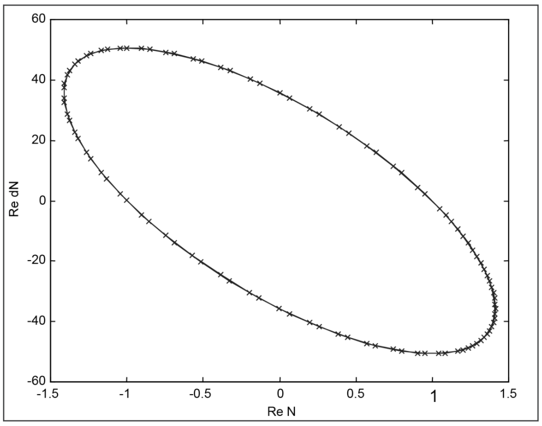

Figure 4. *Radioactivity. J/R=1.0*

At the J/R= 1.01 value (refer to Fig. 5) the third bifurcation takes place when the limit cycle turns into an unstable focus.

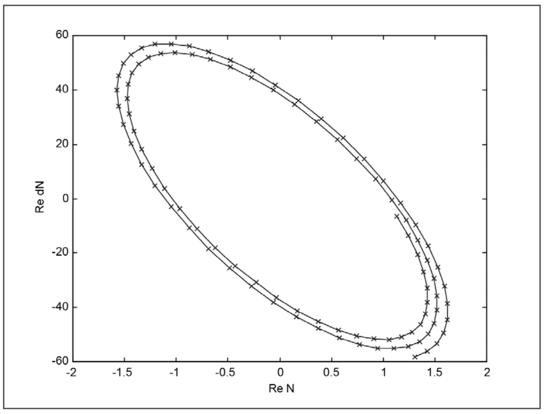

Figure 5. *Radioactivity. J/R=1.01*

The first bifurcation that reveals itself only in the vicinity of J/R= 0 may have a physical content. Even small imaginary parts of coefficients and starting conditions (J/R ≈ 0) result in the qualitative reorganization of the real part of the solution transforming a stable node into a stable focus.

4.1.2 Linear second-order equation with constant coefficients

The equation
$$\frac{d^2y}{dt^2} + \frac{\gamma}{m}\frac{dy}{dt} + \frac{\kappa}{m} = 0 \quad (4)$$
features a mechanical oscillator and an electrical oscillating circuit. Complex-valued quantities are a function y - bias of a particle and parameters: m - a particle mass, γ - a friction coefficient, κ - an elasticity coefficient. As starting conditions we shall take:

$$\begin{cases} y(t=0) = \delta y \\ \dot{y}(t=0) = 0 \end{cases} \quad (5)$$

The solution of the Cauchy problem (4), (5) is known:

$$y = c_1 \cdot e^{k_1 t} + c_2 \cdot e^{k_2 t} \qquad (6)$$

Here, $k_{1,2}$ are roots of a characteristic equation:

$$k_{1,2} = -\frac{\gamma}{2m} \pm \sqrt{\frac{\gamma^2}{4m^2} - \frac{\kappa}{m}}, \qquad (7)$$

Coefficients c_1 and c_2 are determined from the starting conditions (5):

$$c_1 = \frac{\delta y}{1 - \frac{k_1}{k_2}}; \qquad c_2 = -\frac{k_1}{k_2}\frac{\delta y}{1 - \frac{k_1}{k_2}} \qquad (8)$$

Numerical examination of solutions (6) in the complex domain shows that beginning from a certain quantity of ratios

$$\frac{\operatorname{Im} m}{\operatorname{Re} m} = \frac{\operatorname{Im} \kappa}{\operatorname{Re} \kappa} = \frac{\operatorname{Im} \gamma}{\operatorname{Re} \gamma}$$

and if they continue to increase, a root with a positive real part appears among roots $k_{1,2}$ which indicate that the system (4), (5) lost its stability. In the real domain the solution of the problem (4), (5) is always stable. It may be said that solution of the problem (4), (5) in six- measured space of parameters { Rem, Imm, Rek, Imk, Re , Im } is stable everywhere, except for some domains.

Analysis of the expressions (7) shows that the solution ceases to be stable, that is, a real part of one of the roots (7) becomes positive (particularly equal to $0{,}5\times10^{-10}$ Hz) at

$$\begin{cases} \frac{\operatorname{Im} m}{\operatorname{Re} m} = \frac{\operatorname{Im} \kappa}{\operatorname{Re} \kappa} = \frac{\operatorname{Im} \gamma}{\operatorname{Im} \gamma} \geq 10^{-6}, \\ if \quad \operatorname{Re} m = 10g; \quad \operatorname{Re} \kappa = 1000Hz^2 \cdot g; \quad \operatorname{Re} \gamma = 0{,}005Hz \cdot g \end{cases} \qquad (9)$$

and becomes equal to 0.005 Hz already at

$$\begin{cases} \frac{\operatorname{Im} m}{\operatorname{Re} m} = \frac{\operatorname{Im} \kappa}{\operatorname{Re} \kappa} = \frac{\operatorname{Im} \gamma}{\operatorname{Im} \gamma} \geq 10^{-12}, \\ if \quad \operatorname{Re} m = 10g; \quad \operatorname{Re} \kappa = 10^{21} \cdot Hz^2 \cdot g; \quad \operatorname{Re} \gamma = 0{,}05 \cdot Hz \cdot g \end{cases} \qquad (10)$$

The solution for a mechanical pendulum also has a property. Namely, the solution through a bifurcation passes from a stable type to a qualitative another unstable type as soon as the imaginary part of parameters exceeds a certain value.

The obtained results show that fluctuations of imaginary parts of additional conditions and parameters lead in this case to the effect on the real part of the solution, fundamentally different from the effect on it of fluctuations of their real parts.

4.2 Landau Damping Effect

In classical physics, there was one more problem which solution has again required the introduction of complex frequency $\omega \to \omega + i\delta$. The imaginary additive is introduced in the plasma physics and is connected with a so-called collisionless Landau damping. In the perturbation theory of the quantum electrodynamics, the complex mass $m \to m - i\varepsilon$ is introduced. The introduction of these quantities is caused by practically same needs; let's consider them in detail.

In 1946, the paper of L.D. Landau [11] was published as a response to investigations initiated by A.A. Vlasov [12, 13]. Vlasov has faced the following problem: investigation of the dispersion equation for collisionless plasma there resulted in the appearance of an improper integral. The integral in velocity was determined along a real axis and appeared to be double improper were - with infinite limits and polar singularity of the integrand function.

The dispersion equation obtained in the paper [12] is of the form:

$$\frac{4\pi \cdot e^2}{mk^2} \int_{-\infty}^{+\infty} \frac{\frac{\partial f^\circ}{\partial V}}{\left(V - \frac{\omega}{k}\right)} dV = 1. \qquad (11)$$

In the area close to a singular point $V = \frac{w}{k}$, direct integration gives the following result:

$$\int_{-\infty}^{+\infty} \frac{\frac{\partial f^\circ}{\partial V}}{\left(V - \frac{\omega}{k}\right)} dV \approx \left[\frac{\partial f^\circ}{\partial V}\right]_{V=\frac{\omega}{k}} \cdot \int_{\frac{\omega}{k}-\varepsilon_1}^{\frac{\omega}{k}+\varepsilon_2} \frac{dV}{\left(V - \frac{\omega}{k}\right)} = \left[\frac{\partial f^\circ}{\partial V}\right]_{V=\frac{\omega}{k}} \cdot \ln\frac{\varepsilon_2}{\varepsilon_1}, \qquad (12)$$

which depends on the choice of e_1 and e_2, and when these quantities tend separately to zero, does not approach any defined value.

A.A.Vlasov has replaced the improper integral in the expression (11) by principal value on the real axis, i.e. has put $e_1 = e_2$. L.D. Landau pointed to inadmissibility of such procedure and suggested to take the improper integral (11) by the limiting bypass of a singular point $V = w / k$. This bypass is naturally made in a complex plane. There is a problem how to bypass a singular point - from above or from below? Again the adiabatic hypothesis comes to the aid; it requires that perturbation of the distribution function $\delta f(\overline{P}, \overline{r}, t)$ disappeared at $t \to \infty$. In the accepted time dependence $\delta f \sim \exp(-i\omega \cdot t)$ such disappearance means that frequency $\omega \to \omega + i\delta$ has at least a small positive imaginary part. In this case, the pole of the integrand function (11) does not lay any more on the real axis along which integration is conducted, but it appears to be displaced to the upper half of the plane. It gives a rule of bypass of the pole $V = w / k$, which says that it should be bypassed from below (the Landau bypass rule).

In other words, it is offered to take advantage of the relation

$$\lim_{v\to 0}\frac{1}{x+iv}=\frac{P}{x}-i\pi\delta(x). \qquad (13)$$

This expression should be fathomed in the sense of its multiplication by a certain function with subsequent integration. Letter P means that the improper integral is replaced with its principal value, the imaginary value iv is formed as a result of the prior introduction of the complex frequency $\omega \to \omega + i\delta$. This procedure is mathematically correct since complex integration can be introduced along any trajectory, including on such trajectory that $\varepsilon_1 = \varepsilon_2$, i.e. on circles of the radius ε, refer to Fig. 6.

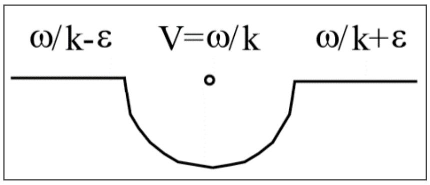

Figure 6. *Landau's rule of bypass the singularity point*

Once again about the main problem of the considered situation: it was necessary to take correctly the non-simple integral (11). For this purpose it was necessary to leave the real axis and go to the complex plane or, what is the same, to assign to the frequency a small imaginary part $\omega \to \omega + i\delta$. This led to the conclusion about the physical possibility of the column-free damping of electromagnetic waves in the plasma (Landau damping).

4.2.1 Statement of the Problem. Complex Wave Vector

However, why only frequency have been awarded here with a small imaginary part, does it has any distinction among other physical quantities? As we have found out, currently complex values for three basic physical quantities have been already introduced: mass and intervals of space and time.

In connection with an idea, developed by the authors [10,14] all physical quantities should be treated as complex-valued. The integral (11) in this case should be presented as

$$\int_{-\infty}^{+\infty}\frac{\frac{\partial f^{o}}{\partial V}}{\omega-kV}dV=\mathrm{Re}\int_{-\infty}^{+\infty}\frac{\frac{\partial f^{o}}{\partial V}}{\omega-kV}dV+i\cdot\mathrm{Im}\int_{-\infty}^{+\infty}\frac{\frac{\partial f^{o}}{\partial V}}{\omega-kV}dV$$

and explore both addends. However, at first, the most simple combinations should naturally be considered. We shall treat only frequency ω and wave vector k as complex.

In this case:

$$\omega-kV\to(\omega\pm i\delta)-(k\pm i\varepsilon)V=\omega-kV+i(\pm\delta\mp\varepsilon V)=x+iv,$$

here

$$\begin{cases} x=\omega-kV \\ v=\pm\delta\mp\varepsilon V \end{cases}$$

Apparently $v<0$, if

$$\begin{cases} 1) & \omega\to\omega+i\delta \quad \text{and} \quad |\varepsilon V|>|\delta|; \\ 2) & \omega\to\omega-i\delta \quad \text{and} \quad |\varepsilon V|<|\delta|. \end{cases} \qquad (14)$$

If the imaginary part of the pole $v>0$, the formula (13) is used; if $v<0$, it is necessary to take the following relation

$$\lim_{v\to 0}\frac{1}{x-iv}=\frac{P}{x}+i\pi\delta(x). \qquad (15)$$

In selecting a positive value of the imaginary part of the complex frequency (18), we are to appeal to the «physical sense,» which recommends removing (to zero) perturbation of the distribution function $\delta f\sim\exp(-i\omega t)$ at $t=\infty$. However, it should be noted that, in the first place, the infinity is physically unattainable, and side conditions on infinity are qualified as incorrect; second, the other physical theories, for example, the big bang theory, allow for the singularity of the system at the start time t_o. «The physical sense» demands the delicate treatment and is frequently introduced to smooth sharp contours of the physical theory that has been basically created.

4.2.2 Solution of the Problem

Let's derive the dispersion equation for the case (15) that require unlike the approach (13) to bypass the singular point from above [10].

In the area of high frequencies under study, plasma can be considered only electronic, the role of heavy ions is reduced only to neutralization of a charge. Then we shall receive the asymptotic dispersion equation [10]:

$$\begin{cases} \Lambda(\omega,k)=1-\frac{\omega_{Le}^2}{\omega^2}\left(1+3\frac{k^2V_{Te}^2}{\omega^2}\right)-i\left(\sqrt{2\pi}-\sqrt{\pi/2}\right)\frac{\omega\omega_{Le}^2}{k^3V_{Te}^3}\exp\left(\frac{-\omega^2}{2k^2V_{Te}^2}\right)=0 \\ \text{если} \\ \left|\frac{\omega}{kV_{T\alpha}}\right|>>1, \quad \left|\mathrm{Re}\frac{\omega}{kV_{T\alpha}}\right|>>\left|\mathrm{Im}\frac{\omega}{kV_{T\alpha}}\right|. \end{cases} \qquad (16)$$

Let's study the equation (16). This is a dispersion equation for longitudinal fast weakly damped waves in collisionless homogeneous isotropic plasma. Damping decrement δ of plasma waves defined by the equation (16) looks like

$$\delta = -\frac{\operatorname{Im}\Lambda(\omega,k)}{\frac{\partial}{\partial\omega}\operatorname{Re}\Lambda(\omega,k)} = \frac{\left(\sqrt{2\pi}-\sqrt{\frac{\pi}{2}}\right)\frac{\omega\omega_{Le}^2}{k^3V_{Te}^3}\exp\left(-\frac{\omega^2}{2k^2V_{Te}^2}\right)}{2\frac{\omega_{Le}^2}{\omega^3}\left(1+6\frac{k^2V_{Te}^2}{\omega^2}\right)}. \quad (17)$$

Change of sign of quantities $\nu = \pm\delta \mp \varepsilon \cdot V$ from positive to negative results in a change from the formula (13) to the formula (15). Expressions (13) and (15) cannot be derived from each other as a result of passage to the limit, i.e. when the value of the imaginary part ν overpass zero, the solution bifurcationally changes from the mode of damping of oscillations to the mode of their antidamping.

Apparently, the damping decrement (17) is positive $\delta > 0$, which means that plasma waves increase of oscillations. So, if the relation (15) is satisfied, at the Maxwell equilibrium distribution the increase of oscillations occurs. The presence of imaginary parts of the wave vector can cause replacement of the process of Landau damping by the opposite process of antidamping of oscillations. Perhaps this sheds light on the still unresolved difficulties with suppression of plasma instabilities in fusion plants.

5. Some Implications. Concerning the Possibility to Explain Fine Structure of Distribution of Measurands by Means of Complex Numbers (Interpretation of S.E. Schnoll's Experiments)

The results of experiments of Shnoll [15-18] that have being conducted by him for half a century can, in our opinion, be interpreted in terms of complex physical quantities. Shnoll generalization of the experimental results reduces itself to the following theses.

1. Careful repeated measuring of a physical quantity leads not to classical Poisson or Gauss distribution, but gives a characteristic structure consisting of narrow lines with maximum in the centre. The fact that each of these lines cannot be considered the distribution of Poisson or Gauss type is of fundamental importance, since average standard deviation in the experiments exceeded the width of this line. Distributions of Poisson and Gauss are only averaging of the revealed fine structure of measurands distribution.

2. Effect of the fine structure is characteristic for all general measurements made in biology, chemistry and physics. Processes produced by all known interactions - strong, weak, electromagnetic and gravitational were investigated. The energy range of phenomena under investigation was of » 40 orders of magnitude.

3. The revealed effect of repeatability of these distributions (histograms) for each day, each astronomical year, etc. makes it possible to draw a conclusion of space-and-time inhomogeneity and anisotropy.

According to Shnoll's just opinion, explanation of these experimental facts can affect our basic view of the universe. Now, we would like to show how the Shnoll's results could be interpreted within the idea of complex physical quantities.

It is well known that any physical quantity can be represented by an algebraic combination of a number of physical quantities called basic: distance x, time t, mass m and charge q. If the basic quantities are complex, all the remaining ones are complex too.

Let measurand S for simplicity be the result of the product of the two other quantities A and B

S = AB.

If

A = a ± iα andB = b ± iβ,

then

S = (a ± iα)(b ± iβ) =

1) ab-αβ ± i(aβ+bα) at α>0, β>0 or α<0, β<0;

2) ab+αβ ± i(aβ-bα) at α>0, β<0 or α<0, β>0;

3) ab ± ibα at β=0;

ab ± iaβ at α=0;

ab at α=β=0.

If at the moment of measuring imaginary parts of quantities A and B meet the condition 1, 2 or 3, the real part of the quantity S took the value 1, 2 or 3, respectively. During next measuring, another condition from these three conditions and so on could be reached. If the results of these procedure are represented in the form of histogram, the pattern corresponding to the fine structure of distribution of Shnoll measurands will be obtained (refer to Fig. 7).

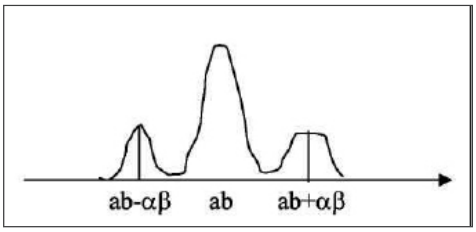

Figure 7. *Proposed theoretical structure of distribution of any measurands.*

Thus, from the fact of existence of a central maximum in the experimental histograms it follows that situation 3 is the most frequent in measuring. More complicated construction of quantity S, for example:

$S = ABC$,

where $C = c \pm i\gamma$,

leads to magnification of the number of the possible combinations implemented in a particular measuring. I.e. various combinations (α, β, γ) give different number of local maxima on the histogram to the left and to the right from the central maximum. Such type of theoretical curves qualitatively corresponds to the Shnoll's experimental histograms.

So, the results of Shnoll experiments that revealed the fine structure of distribution of all general measurands, which differs from classical Poisson and Gauss distributions are interpreted in terms of complex physical quantities.

6. Conclusion

Thus, the made assumption about the complex nature of all physical quantities can become a bridge between the now reigning in science rationalism and panpsychism, the ancient idea of reasonableness and spirituality of Nature. Apparently, it is time to recognize that Nature is not dead, but alive. A new look at the nature of complex numbers, perhaps, will lead to a new toolkit

We have touched upon the fundamental changes in physics, which would be entailed by the possible complexity of physical quantities. In this case a completely new situation arises: natural science determinism in its consistent, full embodiment becomes irrelevant. To what extent and what exactly existing results will change is the subject of further research.

So long cherished idea about the inviolable boundary between the object under study and the subject studying it turns out to be wrong. Quantum mechanics was the first to realize this. It means that one of the main pillars of modern natural science - the requirement of absolute repeatability of the results of measurements confirming any law, irrespective of place and time of these measurements - collapses. If the Universe is alive and reasonable, then the studying “subject” is a hundred percent object of this world universe. Future researchers must realize and somehow take into account this universal connection of everything with everything, a living and intelligent connection. It is time to free ourselves from the ideology of anthropocentrism, laid down in human history by the “Old Covenant” with the “God-chosen” people and developed later by the humanistic post-Christian “revival” that gave birth to modern science, and return to the healthy worldview of our ancestors, who considered themselves and all things in general to be part of animate Nature. Realizing this, it is necessary to integrate into Nature, to interact with it, not to conquer it.

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